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ABSTRACT

This practicum was designed to improve adult skills in facilitating science learning in preschool children by improving teaching staff and parent understanding of active learning and science processes. A series of workshops was presented to pre-kindergarten teachers, family home child care providers, parents, and college students preparing to become early childhood teachers. The workshops consisted of hands-on demonstrations of science activities and learning strategies for preschool children that can be implemented at little cost using readily available household materials. Workshop participants were enthusiastic about the activities and strategies, with post-intervention surveys indicating that they increased the number and frequency of science activities in their classrooms and homes. Seven appendixes provide copies of the survey forms, workshop evaluation forms, journal review checklists, classroom observation checklists, weekly activity plans, workshop plans, and a resource list. Contains 35 references. (MDM)

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Increasing the Frequency and Appropriateness of Science Activities for Pre-Kindergarten Children by Training Teachers In Hands-On Discovery Learning Strategies

by

Dorathea Dixon Gillingham

Cluster XXXIX

A Practicum II Report presented to the
Ed.D. Program in Early and Middle Childhood
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Education

NOVA UNIVERSITY

1993

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PRACTICUM APPROVAL SHEET

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September 15, 1993

This practicum report was submitted by Dorathea D.Gillingham under the direction of the advisor listed below. It was submitted to the Ed.D. Program in Early and Middle Childhood and approved in partial fulfillment of the requirements for the degree of Education at Nova University.

Approved

April 15, 1994 — Georgianna Lowen

Date of Final Approval of Report

Georgianna Lowen, Ed.D., Advisor

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The writer wishes to thank the "wind beneath my wings" who have always supported me,, my husband, Bob, our children, Jim, Charles, Linda and Dan and my parents who provide love, encouragement and the most valuable commodity of all, time.

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The Alhambra High School physics and chemistry teacher ,Mr. Davis, who supported women in science in the forties and fifties changed my life. He included us on the Physics and Chemistry teams and encouraged us to attend High School Science days on campuses which did not yet admit women into their science and engineering programs. He made a difference in the admissions policies of the Universities, and in the lives of women scientists and engineers. Two more friends became my teachers as David McElwain and Dee Paul led me through the computer paths and translated MAC for me.

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ABSTRACT

Increasing the Frequency and Appropriateness of Science Activities for Pre-Kindergarten Children by Training Teachers in Hands-On Discovery Learning Strategies. Gillingham, Dorathea D., 1993: Practicum II Report, Nova University, Ed.D. Program in Early and Middle Childhood. Descriptors: Science Education / Early Childhood Education / Classroom Techniques / Hands-On Discovery / Active Learning / Teacher Education.

This practicum aimed to improve adult skills in facilitating science learning in young children by improving teaching staff and parent understanding of active learning , of the science processes and by using ordinary household materials. A secondary effect was to improve the teachers' and parents' confidence in teaching science by providing opportunities for the adults to participate in hands-on discovery learning.

Workshops were provided to parents, pre-kindergarten teachers, college students preparing to be early childhood teachers and to family home child care providers. The workshops included actual hands-on activities for adults and for children. The participants were enthusiastically involved in successful learning activities. Many of the activities used readily available free or recycled materials. They demonstrated specific materials and strategies such as open-ended questioning and active listening and hands-on, active, discovery learning which encourages concept formation even when child and teacher do not speak a common language.

The workshop participants increased the number and frequency of science activities in their homes and classrooms. They reported their progress in journals. An outcome of the availability of sciencing activities was the children's increased use of the scientific processes in line with the state framework for the K-12 science curriculum.

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November 30, 1993 Dorathea D Gillingham
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CHAPTER I

INTRODUCTION

Description of the Community

The work setting for the writer is a county office of education division responsible for a large pre-kindergarten program for families who meet poverty guidelines. The population involved includes pre-kindergarten children, their families and their teachers. The families meet the federal or state poverty income guidelines except for the 10% of the children with handicapping conditions.

Some children live in single family, multiple family and apartment homes in suburban neighborhoods of a large metropolitan area. Other children live in large public housing projects in urban areas. Some of the children are members of homeless families. The children have little opportunity to play outside because of the perceived danger in the neighborhoods. The communities' drop out rate is above 40% of the youngsters who start high school. Many do not even register for high school.

The teaching staff is 98% female. The requirements to be a teacher are a California Children's Center Permit (CCP), a Department of Justice fingerprint clearance, a tuberculosis clearance and a passing score on a reading, writing, and arithmetic test. The assistant teachers meet all of the requirements except the Children's Center Permit. Minimum requirements for an Emergency Children's Center Permit are 12 units of college credit in early childhood education classes, including Child Growth and Development; Child Family and Community. The programs also require six units of Early Childhood Administration which includes an understanding of licensing regulations. It does not require a high school diploma or its equivalent. One may enter a community college as an

adult student and complete the classes toward a Children's Center Permit. Teachers with the minimum requirements are required to continue taking at least three units a year until they receive a bachelor's degree. One third of the teaching staff are currently enrolled in college. One-third of the teaching staff report no education beyond tenth grade. Supervisors report that one-fifth of the staff are functionally illiterate.

A typical agency report of personnel qualifications shows the following educational levels. Only one of the 27 staff studied has a B.A.; four have an A.A. Fourteen (which includes the five with degrees) have Children's Center Permits granted by the state for a minimum of 12 early childhood education units. Thirteen have 11 or less college units related to pre-kindergarten. The aides have minimal academic requirements. The mothers and grandmothers and other members of the extended families (who shall be referred to as parents) volunteer regularly in the classroom, some as often as two or three times a week. The parents' reported median educational level is third grade. These parents act as teaching aides and interact with the children in the classroom, leading small groups, or playing with a child or children or supervising a table activity. These parents are native speakers of their child's heritage language. Many of the paid staff started as parents in the program and some of the parents aspire to be teachers.

Work Setting of the Writer

The writer is an education specialist who monitors and provides training and technical assistance to many districts, classrooms, and teachers. The writer makes suggestions to the director, education coordinator, or head teacher. The writer observes, and gives feedback to improve programs with the approval of the education coordinator and director. The writer finds, reports, and requests improvement on anything which is out-of-compliance. The writer also teaches child development classes at the local community college and state university on a part time basis.

CHAPTER II

STUDY OF THE PROBLEM

Problem Description

The problem was that science teaching was not evident in the pre-kindergarten (pre-K) classrooms. In many of the pre-K classrooms the writer had recently visited there was little or no opportunity to learn science processes. The classroom might have had old and dusty displays of pine cones, rocks, shells, mounted butterflies or posters, but the teachers and students did not display interest or enthusiasm about these items. One classroom had a microscope, although children this young have trouble seeing anything with one eye only and many junior high students have trouble seeing anything beside their eye lashes. No child was observed using the microscope. The classrooms appeared to have few or no science materials which attracted the children.

This year the school districts in this state selected hands-on science curricula for K-12 students, but no provision was made for children younger than 5. The state developed a framework for K-12 science, but neglected to devise a structure for the pre-K class.

Problem Documentation

In many of the pre-K classes which the writer recently observed there was little evidence of science learning or science teaching. In twelve classrooms a shelf or table which was labeled SCIENCE held only a few shells, rocks, magnet, a plant and a magnifying glass. Seeds were planted in some classrooms and some yards. A fish was

present in some classrooms. Other classrooms had no non-human living thing. In only one of these classes was a child observed using these items.

The self assessment teams of teachers and parents used a checklist to review the classes of their own agency. These teams reported that classrooms needed more science materials.

In weekly activity plans which the writers reviewed, hands on science activities were included on only ten out of 150 days. The writer's review of weekly activity plans revealed some books, crafts activities and songs or fingerplays about insects, animals, and plants. Field trips to the ZOO were taken by some classrooms.

Many pre-K teachers appeared to feel uncomfortable teaching science or did not place a high value on science teaching in the pre-K classroom. Nine teaching staff were interviewed about their knowledge and interest in scientific things. Two showed some interest. One of these demonstrated some knowledge. Seven had no special interest or scientific knowledge. The teacher's lack of enthusiasm for science was visible in some classrooms. When early childhood education students were asked to list the 10 most important things to teach pre-K children; science concepts or science processes were rarely included.

Causative Analysis

One cause of the problem may have been the teacher's lack of academic background in the content of a science curriculum. A survey of 27 teachers revealed that 22 took general science or its equivalent in middle school. This left five teachers without even a 7th grade education in science. Only three had chemistry, or physics in high school. Only one took even one post high school science class. Another cause of the problem may have been that many of the teaching staff felt inadequate to teach science. A survey of

27 teaching staff revealed that only three felt that they knew enough science to teach the children science.

A workshop of hands-on science discoveries developmentally appropriate for 4year- olds was well attended by the teachers, but they were astonished at the results of some of the discovery activities. This may have indicated that their own experiential science background was limited.

An important cause of the problem appeared to be that many of the teaching staff did not like science or were afraid of teaching science. A survey (modified from Sunal, 1975) (see Appendix A) of 27 teaching staff listed: 5 who liked science as a subject, 7 who thought of themselves as a science teachers. Another cause of the problem may be that many of the teaching staff felt inadequate to teach science. A survey of 27 teaching staff revealed that only three felt that they knew enough science to teach the children science.

Table 1

Pre-Kindergarten Teachers

Responses	Number
Teachers who took science in middle school	22
Teachers who took High School Chem. or Physics	3
Teachers who tlook science post High School	1
Teachers who have a Bachelors degree	1
Teachers who have an Associates of Arts degree	4
Teachers who have a Children's Center Permit	14
Teachers who have less than 12 college units	13
Teachers who report that they know enough science to teach	3
Teachers who report that they like science	5
Teachers who see themselves as science teachers.	7
Surveys returned	27

One cause of the problem may have been the lack of advanced science background of community college students who were preparing to be pre-K teachers. A survey of 33 early childhood students in community college revealed that 29 had taken science in middle or intermediate school. This means that four had no science education since the fifth or sixth grade. Although 29 took at least one science class in high school, only seven had taken science since high school graduation. Another cause of the problem might have been that community college students who were currently teaching pre-K or were preparing to teach pre-K did not place science high on their priorities for teaching. Thirty-three community college students in an Early Childhood Education (ECE) class were asked to list ten most important things to teach pre-K children. Two listed science; four listed enjoying learning; three listed cognitive learning; three listed hands-on learning; and two listed nature studies. The total who mentioned something that could have been scored as science was 6 out of the 33. Each student who listed one of these ideas, included more than one of them. The 27 students to whom science was not important enough to list would probably not find it important enough to teach.

Table 2

Early Childhood Education Students at the Community College

Responses	Number
Students who took science classes in Middle School	29
Students who took science classes in High School	29
Students who took Post-High School science classes	7
Students who listed science as a teaching priority	6
Students who were encouraged to experiment as children	1
Students who were punished for experimentations	6
Students who were criticized for divergent opinions	27
Students who were supported for creative thinking	1
Students who reported positive attitudes toward science	8
Students who reported positive Attitudes toward teaching Science	3
Surveys returned	33

One cause of the problem might have been that some pre-K administrators, teachers, and parents did not understand developmentally appropriate pre-K science curriculum, materials, and activities. The science framework (Butts & Prescott, 1990) matched the first five processes and content with children's cognitive development in kindergarten through third grade. The writer believed that these five processes would be appropriate for pre-K classes also. These processes are observing, communicating, comparing, ordering, and categorizing. The content focuses on one-word descriptions, and on discreet ideas. For pre-K through third grade, children learn concepts by participating rather than by reciting rote facts.

Relationship of the Problem to the Literature

Hands-on science has been recommended for years according to Milton Goldberg, a director of research for the United States Department of Education. However, students' active participation in science has declined in recent years. Students spend more time in lecture or textbooks than in science lab work. Of eleventh graders only 59% have ever written up an experiment and only 20% have ever been on a science field trip (Fisher, 1992b).

The need for improved science education for America's children is well documented. Our nation includes science as a national priority. Governor Roy Romer was chairman of the National Governors' Association panel that wrote the six American 2000 goals (Fisher, 1992a). The fourth American 2000 goal expected the American students to be first in science and mathematics achievement (Bush, 1991). Ex-President Bush himself had set a personal goal to become computer literate. Following his lead each adult might set a personal goal to increase science and/or technical knowledge and/or skill. Governor Romer believes that it may be impossible for our students to become first in science and mathematics achievement (Fisher, 1992a).

Butts and Prescott (1990) reported that America's students score below the students of every other developed nation. They often lack the understanding of basic science concepts necessary for success in middle school and high school science classes. Children entering middle school science classes lack background and hands-on experiences in science according to middle school science teachers (Sciaroni, 1991). Donald Lapp, of the National Science Resources Center, reported that science has almost disappeared from elementary schools. It is often presented so badly that it does not inspire children to enroll in science in later school years (Fisher, 1992a). African-American and Hispanic students are often the farthest behind (Hayes, 1992). The student ethnicity in the writer's agency is 17.8% African-American and 68.5% Hispanic. 98% of our families live below the poverty level. These students are the least likely to succeed in school (Hayes, 1992). Special efforts must be made to prepare minority children for the future world of science. They will form a large part of the work force in the year 2010. The educational system from kindergarten through twelfth grade will have to be radically revised to make the United States a nation of scientifically literate citizens.

In today's technology employers are looking for employees who have a positive attitude toward science and technology and have some of the basic skills and understanding of scientific concepts and scientific methodology. If current trends continue we will have a shortfall of 700,000 technically trained employees. We will have a shortage of 400,000 who have a bachelor's degree and an additional shortage of 9,600 doctoral degrees in science and technology. Perhaps most important is the shortfall of scientifically trained employees who can put the ideas into everyday practice (Fisher, 1992a).

Many elementary school teachers are "uncomfortable teaching math and science", said the National Science Foundation's Luther WIlliams (Fisher, 1992b, p. 82). Every year we lose 13 experienced science teachers for every one new science teacher (Fisher,

1992b). We need to recruit science teachers, help teachers to become science teachers, and support teachers so that they can stay teachers.

Brain-based learning research suggests that emotions are critical to learning (Caine, 1990). Emotions and cognition cannot be separated. The emotions facilitate the storage and recall of information (Rosenfield, 1988). The emotional climate should be supportive with a mutual respect and acceptance (Caine, 1992). Because learning involves the entire body as well as the mind, anything which affects the body affects the capacity to learn (Caine, 1990). Emotions, nutrition, general health and the general learning environment affect learning (Caine, 1990). Attitudes toward any subject affect the long term memory about things learned as well as the interest and participation in the lessons now (Krynowsky, 1985). Scientific attitudes are presumed to be the attitudes that are held by professional scientists and are worthwhile objectives for science teachers and students (Krynowsky, 1985). All of the domains of learning: cognitive, affective, and psychomotor must be involved (Pallas, 1988). Perhaps a positive attitude toward science will improve the learning and retention of scientific knowledge.

The problem appeared to be that developmentally appropriate hands on science activities are not used by the children in the pre-K classrooms. The writer proposed that the adults, teaching staff, parents and students preparing to be teachers have not been prepared or trained to provide developmentally appropriate activities which will be enjoyed by the children. Many of the adults did not enjoy science themselves and have limited knowledge of science and its processes.

Chapter III

ANTICIPATED OUTCOMES AND EVALUATION INSTRUMENTS

Goal

The following goal and expected outcomes were planned for this practicum. The goal was that developmentally appropriate hands on science activities would be used by the children in the pre-kindergarten classrooms.

Expected Outcomes

1. The teaching staff and workshop participants would develop a more positive attitude toward science, and toward themselves as science teachers.

2. The teaching staff and parents/workshop participants would enjoy hands on discovery learning themselves.

3. Hands on science activities would be available in the pre-K classrooms four out of five days.

4. Hands on science activities would be included in the weekly activity plan every week.

5. The workshop participants would model a science activity for our class.

Measurement of Outcomes

The expected outcomes would be measured and evaluated.

1. The teaching staff and workshop participants would develop a more positive attitude toward science, and toward themselves as science teachers.

The participants would take several informational surveys (see Appendix A) during the practicum period. The workshop participants would develop a more positive attitude between the first and last survey. On the last survey 25 out of 30 individual participants would circle five more words which describe positive attitudes toward science than on their first survey. These increased favorable responses would be both toward the subject of science and their own teaching of the subject of science.

2. The teaching staff and parents/workshop participants would enjoy hands on discovery learning themselves.

It was planned that each participant would have many opportunities to try hands on discovery learning in a group setting. Evaluations (see Appendix B) would report which, if any, of the science activities in which they participated during the workshop they would provide for their own class. Fun which they experienced during the workshop would be named or described. Journal entries (see Appendix C) would describe the satisfaction which participants felt with their science experiences in their own classrooms, with their own family, and in their own life. Although some participants might start these experiences with journal entries which could be described as apathetic, tired or bored, 25 of the 30 participants would within six weeks write about positive feelings which could be described as satisfaction or joy.

3. Hands on science activities would be available in the pre-K classrooms four out of five days.

Classroom observation (see Appendix D) would indicate science activities available in the classrooms at least four out of five classroom visits. Classroom observation would find children doing science at least four out of five visits. Journal entries (see Appendix C) would reflect an increase in science in the classroom. Classroom observation (see Appendix D) would find teachers facilitating the processes at least four out of five visits. Classroom observation would find children using the processes at least four out of five classroom visits.

4. Hands on science activities would be included in the weekly activity plan every week.

A review of the weekly activity plans (see Appendix E) or lesson plans would show developmentally appropriate science every week in 55 out of 60 of the plans reviewed. Review of weekly activity plans (see Appendix E) would find activities which develop the processing skills in 55 out of 60 of the plans reviewed.

5. The workshop participants would model a science activity for the class.

During one of the class sessions 28 out of 30 participants would demonstrate a hands on science activity, bring materials, and a lesson plan for classmates. Reading the journal entries would explain some of the learning involved in the selection and presentation of the activity.

CHAPTER IV

PROBLEM SOLUTIONS

Discussion and Evaluation of Solutions

The need for improved science education for America's children is well documented. For example California's education goals (Science, 1987) include concepts such as preparing youth for skilled and literate employment, developing informed citizens for a democracy, learning not only the basics, but the core concepts of subjects including science and the history of scientific discoveries (Science, 1987).

There is a wide interest in science education. This year school districts will be choosing science curricula for K-12 classes (Science, 1992). Project 2061 (American Association for the Advancement of Science [AAAS], 1989) is based on the need for all children to have the basic education in science which prepares them for an interesting, productive life. Special efforts must be made to prepare minority children for the future world of science. They will form a large part of the work force in the year 2010 (AAAS, 1989). The educational system from kindergarten through twelfth grade will have to be radically revised to make the United States a nation of scientifically literate citizens. The first step is understanding what scientific literacy is. It is not just learning facts, but being able to function in a technical society. It is being an educated consumer of science; it is being an educated citizen/voter/taxpayer. It involves using the scientific processes: to observe, communicate, compare, order, and categorize (Butts & Prescott, 1990).

Some of the possible solutions found in the literature include starting instruction in science early by studying and matching curriculum to the developmental readiness of pre-kindergarten (pre-K) children. Pre-K children are cognitively developmentally ready to

learn science processes rather than isolated facts (Butts & Prescott, 1990). Pre-K children have an enthusiasm for school and for learning. The task is to help them to keep this positive attitude and to develop this enthusiasm in adults as well as the children. They have an excitement and curiosity about learning which comes from discovering concepts through manipulating and observing. The developmental view of learning is that the teacher is not the source of knowledge and the student the container, but that the teacher is a learner alongside the child.

Pre-K children need to learn developmentally appropriate science concepts in developmentally appropriate ways. Hands-on active discovery methods are appropriate (Bredekamp, 1987). The four year old's development and the first five science processes are an excellent match. The four year old likes to observe, communicate, compare, order and categorize (Butts & Prescott, 1990). Adults need to let children observe with their eyes, fingers, and all of their senses in order to immerse themselves in the properties and attributes of whatever they are observing. It may require change for adults to learn to value the child's comments and representations of that which was observed. Children need opportunities to report what they have learned with their whole bodies, with art materials, and with other things within their environment. Those things which they have observed need to be communicated in order to fully be understood (Butts & Prescott, 1990).

An example of matching curriculum to children's development is teaching classification. The teacher needs to consider the child's developmental abilities and not just the "scientific" categories and classes. She should encourage the children to focus on the real properties of the objects such as size, shape, color and texture. In fact children will do this naturally, if the teachers do not interfere by using the scientific classifications which may be based on invisible characteristics (Benham, Hosticka, Payne, & Yoetis, 1982).

An important element is independence in learning. This empowers the children to make their own discoveries without requiring an adult guide. Independent discovery requires a large block of time, space, choices, and freedom to try. It also requires a variety of accessible materials, and a learning environment which provides stability and familiarity (Caine, 1990). The teacher's role is to create a place conducive to discovery and to lead in creative open-ended questioning, encouraging experimentation and exploration (Follis & Krockover, 1982). One solution may be hands on discovery learning in the classroom with an emphasis on the teacher's use of open ended questions and acceptance of divergent ideas.

The most important parts of science learning are the gathering of information, organizing of this data, and the analyzing and evaluating the information. This occurs with hands-on activities in an atmosphere where creative and divergent answers are honored and where investigation is facilitated (Feng, 1987). To act like a scientist the child must actually observe, describe, communicate, measure, infer, and predict. Acting like a scientist involves hands-on experiences with concrete materials (Feng, 1987). The state Curriculum Development and Supplemental Materials Commission (Butts & Prescott, 1990) requires that the materials include the excitement of science by actively engaging students in "doing science". It is the processes that are the most important part of science for the pre-K child to experience. To process is to act like a scientist. Role-play (acting like a scientist) is a very appropriate cognitive activity for young children (Smilansky & Shefatya, 1990).

Hayes (1992) suggests that the low science scores of students may be due to "back to basics" education in which students spend time learning and reciting one word answers to simple questions or answering pro forma questions on worksheets. Thus, students are not developing their critical thinking as they would be if they were solving their own problems. The open-ended and thought provoking questioning by the teacher may help in

the problem solving and critical thinking. Consciously allowing the child time to work it out may also help.

The teacher's skilled use of inquiry encourages children to test and explore rather than depend on the adult answers (Follis & Krockover, 1982). Open-ended questions and thought provoking questions draw the child out and encourage him to formulate and express his ideas (Cazden, 1981). Active listening without interruption or correction seems to help the thought process. Interruptions seem to entangle the thought processes with concern for grammar and correctness (Cazden, 1981). Simple encouragement allows the child to do the problem solving. Helping children to want to learn and to know that they can learn is important (Science, 1987).

"Learning is not obtained by chance; it must be sought for with ardor and attended to with diligence." wrote Abigail Adams in a letter to her son John Quincy Adams (in Science, p. vi). Allowing children to construct their own knowledge with hands-on discovery activities allows them to practice diligence and seek the answers with ardor and develop the habits of learning which will help them in later years. Supporting the problem solving and critical thinking with silent or enthusiastic presence, but without giving adult ideas seems to help the child (Science, 1987).

The AAUW study recommends offering "hands-on" science and math experiences and opportunities to work on science and math in cooperative groups (AAUW, 1992). Children need to be physically and mentally active, touching and experiencing concrete, real materials. The activities must be relevant and within their experience (Bredekamp, 1987). Teachers must recognize that even scientists can learn from untrue hypotheses, when they have choices and ample opportunities to experiment. The teacher's role is to be the facilitator, and questioner, who provides a supportive emotional climate and different materials to test for different results.

The goal for 4-year-olds is in the process: the observing, describing and communicating (Bredekamp, 1987). Children learn about science by integrating meaningful activities and observing and interacting with people and with things and by seeking solutions to questions and problems. By trying to solve questions and problems using concrete objects, children construct knowledge of themselves, others, and things around them. They build, measure, observe, sort, explore and represent (Bredekamp, 1987). Children want to make sense out of the environment and people around them; they are naturally curious (Bredekamp, 1987). Emphasizing science's applications to the students and their daily lives using a process approach has been very successful in Texas (Kyle, Bonnstetter, Gadsden, and Shymansky, 1988). Would having active learning in the classroom which is applicable to daily lives in the family home, help the parents to feel comfortable with the classroom science activities?

Cognitive research which is now focusing on what children can actually do at a particular time in their development focusing on how they solve a problem, reveals the wide range of strategies they use (Stein, 1980). For instance, in counting, the younger the child, the more it needs to point at or touch what it counts. Developmental age changes the child's problem solving techniques (Stein, 1980). Young children need to have hands on opportunities to touch and change things in order to concretely solve problems and develop concepts. The National Science Foundation is supporting Research in Science Education and Memory and Cognitive Processes from which Stein has taken information about "cognitive bugs" which cause college students and adults to keep misconceptions which they learned very early in their education (Stein, 1980). The writer believes that this work supports the conclusion that children should "do science" rather than learn some rote version of science which may leave them with cognitive bugs and no way to reconstruct more accurate knowledge.

If one has poured a lot of water, and seen a lot of water pouring from holes or rocks or pipes or irrigation devices, one can understand the way that water pressure can effect things. If one is merely taught that water has pressure, one may still be surprised at where the water falls, when the object compresses, or how jelly fish can exist at great depths in the sea. Young children need to generate, organize, and evaluate what they see happen, not merely memorize science concepts (Feng, 1987).

Careful attention to teaching strategies may be a solution. How the teacher introduces the materials or activity is crucial. The teacher is not the information giver and the student the sponge (Feng, 1987). Children are curious about new materials and about discrepant events (Bredekamp, 1987). Teachers can provide many different materials and activities. The different materials and activities are chosen to match the differences in the children: different levels of ability, development, and learning styles. The materials and activities are changed to increase difficulty, complexity and challenge (Bredekamp, 1987).

When teachers demand rote word or sentence repetitions rather than asking open ended questions or using conversational dialogue, the children may assume that their role is to recite or regurgitate the teacher's ideas. During conversation which includes leading and open-ended questions, children may assume that they should state their own creative or critical problem solving idea (Bartlett, 1981).

Tipps (1982) suggests that if the teacher specifies the activity or the method, both the questions and the answers are predetermined. Using the example of a sink and float activity, Tipps' model teacher would ask, "What happens to objects put into water?" The children can imitate the actions on action task cards without knowing what the teacher wants as the outcome. The teacher can present puzzling outcomes. Although nails always sink and wood always floats, a paper towel floats until it is saturated. Some crayons sink; others float. Aluminum foil can be made into a boat or a solid sinking object.

Tipps (1982).reports on a first grade class who made a third category, "sometimes sinks, sometimes floats." Activities such as sink and float with time, materials and the open-ended questions and enthusiasm of a caring adult develop the child's ability to "do science", to develop his competency in the science processes. Planning the room arrangement and accessibility of the materials allows the children to independently experiment and participate actively (Follis & Krockover, 1982). This type of activity requires the materials and the implicit permission for mess (water) in the classroom. Another important consideration is time - enough time for a child to try every option.

The material should be available for what adults call "freeway thoughts" or "midnight thoughts". Those thoughts which occur while one is driving home or as one falls asleep need to be tested. A one day discovery activity does not encourage long term thoughtful creative problem solving. The opportunity to come back again and again encourages the child's developing cognition. It entices him to observe for new questions and new discrepancies to explain. Materials must be accessible for children to do the activity again.

Another solution may be a change in pupil assessment from a simple test score to the portfolio or authentic assessment method. For almost 30 years process skills have been a part of elementary school science curriculum, but the program evaluation was not focused on practical skills, but on knowledge of facts (Doran, 1990). When K-12 children keep science notebooks, with their thoughts, predictions, experiments, procedures, and results, these notebooks can be reviewed and rated for competency. There is a curriculum reform implicit in the reform of assessment now going on (Bracey, 1992). Multiple choice tests favor simple rote answers, but the authentic assessment, portfolio assessment, and use of student notebooks favor cooperative and collaborative learning with critical thinking, problem solving and actual hands-on activities (Meng & Doran, 1990). Unfortunately the

writer's effect on assessment methods can only be the tangential planting of this thought. Momentum is building for authentic assessment, but change will come slowly.

Bracey (1992) describes a method which Baxter and Shavelson use to observe students doing science which is even more reliable than notebooks and correlates with the Comprehensive Test of Basic skills. The research showed that the science notebook is correlated at .83 with the observations which is very good considering how much easier it is to look at notebooks than to observe every student. How can pre-K students keep a notebook or journal? Can we assess the children by using the teacher's journal or notebook observations of the children doing science?

Valuing the processes of science over the content of science, will dramatically change what a science curriculum is. Tipps (1982) suggests that learning to estimate and predict using the science curriculum as the means and learning to guess as the end is an important goal of early childhood science. Butts and Prescott (1990) include a developmental sequential chart of the scientific processes and the age and stage where the child is best able to use them. The processes of observation and description and communication are developmentally appropriate for children who are 2, 3 or 4-year-old and who are learning language. "The facts represent the product of science. To teach only the product of an enterprise is to minimize the importance of the processes that produced the product, moreover, when the process is ignored, the product cannot be fully understood. Exactly what problem an individual will be required to solve is unpredictable; yet, unless this is known, it is impossible to decide what facts he is going to need in order to solve the problem." (Feng, 1987, p. 6).

Follis and Krockover (1982) stress the need to engage the child in problem solving experiences that encourage advanced abstract thinking. Opportunities for hands-on discovery learning develop the abilities to observe, predict, and ask questions. The use of the inquiry method utilizes questioning techniques which develop concepts and higher

level thought processes. Discovery learning is designed to arouse the curiosity with discrepant events using skilled questioning. Children need to be taught the skills for creative and critical thinking (Pallas, 1988). Building skills such as critical thinking, inventiveness, persistence, and curiosity form positive attitudes toward science and the skills are useful into adulthood. Because early childhood education includes several major philosophies such as behaviorist-environmental, maturationist, and comprehensive-interactionist no single narrow method of science teaching is likely to be accepted in all programs. The challenge is to find some approaches and activities which can be used in various programs and which will enhance the children's science learning (Sunal, 1982). This practicum focuses not on a particular curriculum, but on creating an atmosphere for learning. Two important components will be a classroom with accessible materials, time, space, and a supportive, enthusiastic, curious, questioning teacher with a positive attitude toward science.

Although it may seem difficult, teachers do change when they understand it helps children and when the teacher learns some specific strategies. When eight teachers of Kindergarten through third grade were trained in conceptual change science (Neale, Smith & Johnson, 1990) they developed lessons on light and shadows which were video taped. The children were interviewed to measure their understanding of light and shadow before and after the unit was taught. The teachers wrote evaluations. One year later the teachers were interviewed. The eight teachers were generally successful in changing the students' conceptions and in using new techniques and strategies to obtain the conceptual change. One of the new techniques which the teachers learned was focusing the child's attention on the variables in light and shadow. For kindergarten this was simply asking questions about the direction and travel of light (Neale, Smith & Johnson, 1990). One of the new techniques was providing discrepant events to challenge misconceptions. Important factors in the success of changing teacher's way of doing science included:

support from administrators, acceptance by teachers, clear guidelines, timely training in skills, ongoing support from peers and coaches, and modification of organizational constraints (Neale, Smith & Johnson, 1990). One of the changes mentioned by teachers in interviews was their increased interest in listening to the child's ideas.

Student teachers and early childhood students are eager to make changes in the teaching methods found in real classrooms (Carter, 1992). Some classrooms are teaching children with didactic and inappropriate methods. For instance, in one class room the master teacher used quotation marks in a sentence for beginning readers. When questioned by the student teacher, the master teacher responded that if the children saw quotation marks enough they would understand them by second grade (Carter, 1992). The student teacher (Carter, 1992) had been taught that: 1. Children learn best by active learning. 2. Working through a problem builds problem solving and critical thinking skills. 3. Success builds self-esteem which increases time on task and problem solving.

Carter discovered that the principles which she had been taught were not being used in the class where she was an intern and she had to find out how to implement some of them within a very tight time schedule. This report is a very real story of what needs to be done to incorporate active hands on learning into a structured classroom and bring joy and excitement into learning. (Carter, 1992). The student teacher learned that: 1. Collaboration with other teaching staff is necessary. 2. Peer support and supportive inservice programs are necessary. This practicum will provide opportunities for collaboration and peer support within a supportive workshop.

The problem appeared to be that developmentally appropriate hands on science activities are not used by the children in the pre-Kindergarten classrooms. The writer proposed that the adults: (teaching staff, parents and students preparing to be teachers) have not been prepared or trained to provide developmentally appropriate activities which will be enjoyed by the children. Many of the adults do not enjoy science themselves

and have limited knowledge of science and its processes. One solution may be workshops for the adult in which they enjoy "doing science" and develop a more positive attitude as well as learn some activities and strategies for the classroom. This practicum intends to provide opportunities for collaboration and peer support within such a supportive workshop.

Traditional science education for young children includes demonstrations of things such as magnets and magnifying glasses. The children find out which objects are attracted to magnets and which are not. Magnifying glasses are used to help in observing objects or bugs. But Piaget's notion (1977) is that children learn, not merely from observing and describing but from acting on objects physically and mentally and then observing the results. Kamii and Lee-Katz (1978) recommend activities where the "children can produce the phenomenon with their own actions and can vary the actions" (Kamii, 1978, 171) and ones in which the " children can observe the object's reaction, which is clear and immediate" (Kamii, 1978, 171). Because it is the magnet that causes the action rather than the child, she rejects magnet play as an appropriate cognitive activity. She recommends rolling, tilting, dropping, blowing type activities in which the child is in total control of the causative action. During the workshops adults will be able to try both types of activities and learn the difference in the quality of cognitive construction of knowledge within themselves.

A successful program to change the style of teaching science is described by Yopp (1990). She describes her success in a science methods class which teaches teachers to identify instructional strategies for including scientific processes and attitudes in their lessons rather than only content. Inservice teachers met in grade level groups and wrote lesson plans which they presented to the whole inservice class. It was a cooperative workshop. The teacher/students were women. The AAUW (1992) research encourages cooperative workshops for women. Neale, Smith and Johnson (1990) explain how they

taught teachers to teach concepts of light and shadow to children in kindergarten through the third grade. There were concept-changing and cognition lessons, modeling of teaching and observations. The teachers then used the techniques in their own classrooms. The teachers were observed and interviewed. The research team found value in the teachers' journals of successes, frustrations, failures, and difficulty of implementation of "new" strategies and concepts. Perhaps journals of the teaching staff and workshop participants would be useful in this practicum.

One of the methods of increasing the frequency of science activities in the classroom may be to develop positive attitudes toward science in the teachers who are mostly women and mostly ethnic minorities. This can be done by giving them opportunities to play and discover for themselves. They can be relieved of the responsibility to "know all the answers". They can understand their role as asking leading open-ended questions and listening actively and themselves trying the materials with a curious and enthusiastic enjoyment. The most important consideration is the attitude of women teachers toward science, the low self-esteem of some students, the parents' attitude toward science and toward their own skills in science. The second consideration is focusing on the process of science more than on the academic content of the lessons.

One of the reasons children (and adults) do not succeed in school or in life may be that they lack the self confidence to try and to risk being wrong. Developing self esteem in the children and in the adults may be one solution to increasing the persistence and success in dealing with science activities. If we believe that "Si, se puede- yes, you can do it," the children and adults will believe that they can do it. Self esteem and the "I think I can" view toward school assignments can help the children, teachers and parents through many years of school.

Description of the Selected Solution

Empowering the parents by honoring the science which they know and by describing for them the science which they know that they know science may improve their attitude toward science in the home and as volunteers in the classroom. Having parents participate in workshops where they identify in which science they are already an expert should provide some of this self-esteem and power. For instance, migrant farm workers know botany, weather, geology, and chemistry, but may consider themselves ignorant laborers. If a team of parents and a teacher had a lesson planning workshop for parents explaining the subject matter and drawing from the parents the information to create some learning experiences for the children, the parents would be elevated to the role of science teacher when they next volunteered in the classroom and helped with that discovery learning. They can find food in fields. They stew edible weeds and make salads of other edible weeds. But they may not know that the classification of the plants is botany and that they are an expert in the lupine, pea and bean family of plants. They may not know that they know all about monocotyledon and dicotyledon seeds.

By focusing on the goal of teaching the scientific processes as described in Butts and Prescott (1990) the children and the parents are empowered to do science. The semantic vocabulary in English and in Latin can be learned rather easily later, if the concepts have been discovered and the processes mastered.

The writer planned to present workshops with follow-up for parents and teaching staff, and to encourage and coach staff and parents by replying to journal entries. The writer planned to present workshops for assistants and teachers in hands on science with scrounge (free or recycled) materials to demystify science. The workshops will answer the question, what is a good science lesson?

The writer planned to develop a one unit University Extension class for teacher preparation in the teaching of the science processes for early childhood in line with the

state science curriculum framework for K-12. The writer planned to develop and give a workshop for parents which empowered them to discover with their children and to think about the science discrepant events in their own home. What happens when you add salt to boiling water? What happens when you add salt to melting ice? Is it physics? Is the key a change in temperature? Or is it chemistry? Is it the study of solutions?

At a recent workshop the writer melted ice under several conditions. In trying to develop some thinking about the adding of salt to ice the writer asked what happens when salt is added to boiling water. The answer was agreed upon by 10 out of 12 participants. The water cools. The evidence is it stops boiling. This response was the key event which convinced the writer that the teaching staff has lived life, but experienced it without the benefit of an open questioning attitude. They have not tested, questioned or measured. No one had measured the temperature! It is this process of questioning and testing that the writer hoped to improve.

The writer proposed to develop a workshop for pre-K parents and teachers and do it at various conferences. The plan is grounded in the developmentally appropriate concept of hands-on discovery learning while playing. It is grounded in developing the skills of the scientific process rather than rote memory of science facts. Enthusiastic attitude building is among the writer's skills. Evaluation of the first activities should lead to the development of the criteria for useful and appropriate pre-K science activities. Workshop participants will write journals of implementation successes and failures. This will lead the writer/reader through their change process and document the implementation of "doing science".

REPORT OF ACTION TAKEN

Each month at least one workshop was presented for adults who work with pre-Kindergarten (pre-K) children (or are training to do so) on the topic of hands-on science with readily available materials. The first four workshops entitled Hands On Science with Free and Recycled Materials were given back to back at High Scope Educators Workshops on Saturdays. There were repeated the next month in another part of the county. Within this six week period the ideas and materials were presented to four separate groups of pre-K teachers and caregivers who were interested in the High Scope Curriculum. High Scope is a curriculum which stresses children's choices and active learning. The combined attendance was 121. Each workshop was one and one-half hours. An initial active learning warm-up was followed by the participants brainstorming the essence of pre-K science and a 10 minute lecture on the new science framework (Butts, & Prescott, 1990) for grades K-12 and how it works for pre-K children. Next was a lecture on the High Scope Key Experiences and how they fit into science. After this 20 minutes of overview, hands-on science was available at the various tables and work stations which the writer had set up. The writer's role for that seventy minutes was to roam from group to group with open-ended questions about the science experience and questions and suggestions for implementing these ideas, strategies, and materials into the individual participant's classrooms and homes. It required the organization of many materials since some are not reusable by different persons. The process of doing four workshops during a short time period and then reorganizing and making substantive changes in the workshop was very effective. The major purpose of the workshop was to increase positive attitude toward science. The primary resource was enthusiastic, supportive workshop leadership. The primary strategies were ample materials and time for trying things ,communicating findings to others and brain storming other applications in the participants classrooms or homes. The secondary purpose was to increase the frequency of science activities within the participants' classrooms and homes. Some of the supervisors of some of the

participants report that there is more science in those classrooms now. These supervisors have asked the writer to bring such a workshop to their district. These workshops were so well received that for two weekends in October of this year, the writer gave three hour workshops on science using free and inexpensive materials for the same sponsor.

The fifth workshop was for home visitors, parents and care-givers of children 0-3 in a home-based program. It was presented twice in one day for one and one half hours with a total of 21 participants. The writer demonstrated using household and recycled materials which would be readily available in order to empower the parents to replicate the activities for their relatives and neighbors. The major emphasis of the first part is health and safety, because children under three put things in their mouth and may choke or be poisoned by objects in the home and yard. One of the favorite activities at this workshop was using different materials to make bubbles so that the children could discover that it is not the shape of the hole which makes a bubble spherical. Bubbles can be other shapes, but the surface tension dictates that they always cover the area with the least expanse of bubble surface. We used plastic strawberry baskets. We used string with short pieces of straw strung on it to make squares and cubes and pentagons and triangles and pyramids. The two-year-olds can wave the sections of berry basket through the air to make many tiny spherical bubbles; their blowing is usually not well enough developed to make the traditional bubble wand bubbles. Another favorite activity was making magnifying glasses with plastic food containers and water. In fact this was the activity which most interested the adults in each workshop. Many concoctions of salad oil, water, and food coloring were made in mineral water and soda bottles for the babies to look at, roll on the floor as they crawl and shake around. We added detergent to some to show how it mixed things together. The mixture is not an attractive baby toy. It is a discrepent event for an older child or for the parent. What does detergent do to oil and water?

The sixth workshop was for about 50 parents of gifted young children. It was presented at a state conference for the gifted. For this workshop the co-presenter was a

middle school science teacher/coordinator of the gifted program. The presenters wanted to demonstrate how hands-on activities allow the children to construct the knowledge at their own level. Different cognitive levels, different interests, and differing levels of scientific knowledge can be accommodated with the same materials and similar activities. The presenters showed how a whole family could use the same materials and still enjoy appropriate learning. The processes of science were demonstrated but were not the focus of the workshop as they had been for the audience of pre-K teachers. Some of the topics were predicting and estimating, water, ice, solutions, colloids, geometry of bubbles, classification of shells and seeds, music and sound. We created several handouts for families.

The seventh workshop was not in the original plan, but an opportunity at a local university to teach an evening section of creativity and critical problem solving skills for young children allowed one evening and parts of others for science processes. The seminar style class only had nine participants. The students were the first to which the writer assigned journal writing. The small class allowed longer time to "play" with each set of materials and to make more adaptation and variations and extensions of the activities. The journals were very revealing of the participants reluctance to "teach science" and of their need for support from someone who understood science and their deeper need for someone who trusted them to allow children to learn on their own through manipulation of materials.

The eighth workshop was an opportunity to help a group of twenty-one Spanish speaking teachers to write weekly activity plans to be used for themselves, reviewed by their supervisors and monitors who review the classrooms and documentation. Of course, the focus was the science lessons. The issues were cultural and linguistic as well as how/when/why to provide science experiences for the children. They were the most curious about the sources of materials. It was in this workshop that I realized that concrete learning and active learning are essential in cross-cultural, cross-linguistic

trainings. They spent more time looking at the containers for the white powders and local sources for shell and buttons for the classification and seriation experience. They especially enjoyed the activities with the materials with which they were already familiar more. For instance after watching a tuning fork in water, listening when it was on their elbow or on a box or on the table, we made sounds with wire hangers and strings held to our ears. The joy of discovery on their faces was wonderful. One group was sent out of the room to try an experiment and had them report it back to the class by speaking through a garden hose which went out the door and around the corner to their work station. Again there were big smiles and everyone talking and listening with the garden hoses. During the next week many surprised families discovered that the garden hose was not attached to the faucet, but was a message carrier from around the corner to this room and out the door to that child.

The ninth workshop was a short demonstration at a meeting of Head Start Child Development Supervisors and Education Coordinators. The writer demonstrated some free and inexpensive activities and materials for classroom science. This group also brainstormed some monitoring procedures to ensure that science activities are more frequent, more open-ended with more active discovery hands-on experiences for the children. Again all of the evaluations were positive with some comments on the usefulness of some of the demonstrations and participatory activities.

The tenth workshop was for teachers and caregivers of children 0-3 in a full day child care. Thirty five adults from three locations of a Day Nursery met on a Saturday morning to learn more activities for the children. Activities included touching and experimenting with many materials including hair gel and various food colloids, solutions and mixes. Experiments with ramps, friction and wheels appeared to be totally new ideas for these participants.

The eleventh workshop was for family day care providers. The focus was on teacher made science equipment. First we had an active learning activity which contrasted

coloring a picture of an airplane with folding paper airplanes. The participants brainstormed what they knew or could demonstrate of aerodynamics, air, and the science of flight. Take home products of the activities included milk carton cages for lady bugs, food container magnifying glasses, wire hanger balance scales, ruler and rubber band weighing tools, a fulcrum and lever beanbag launcher. The writer also showed preserving a bird's nest without the accompanying parasites and how to clean pennies with vinegar and salt.

Although there were only 15 caregivers present they were very enthusiastic about finding out how to encourage children to think critically and to do science even when the adult feels ignorant about science. Fifteen out of the fifteen raised their positive feelings about science and about themselves as science teachers. Family day care homes present a special problem because children who put things in their mouths and who crawl through messes on the floor are present with school age children who need the stimulation and opportunity to make creative messes. For this audience, special attention to health and safety issues for infants and toddlers was very important.

One of the things which proved to be necessary, which was not anticipated during the proposal of this practicum was the creation of a display and lending library of appropriate science activity books for the interested participants. The list of the books appears in Appendix G. The most used items in this lending library are the three notebooks full of the children's nature magazines, Ranger Rick and Your Big Backyard.

Chapter 5

Results, Discussion, and Recommendations

Brief summary of the problem and solutions strategy

The problem was that science teaching was not evident in the pre-kindergarten (pre-K) classrooms. In many of the pre-K classrooms the writer had recently visited there was little or no opportunity to learn science processes. The problem appeared to be that developmentally appropriate hands on science activities are not used by the children in the pre-K classrooms. The writer proposed that the adults, teaching staff, parents and students preparing to be teachers have not been prepared or trained to provide developmentally appropriate activities which will be enjoyed by the children. Many of the adults did not enjoy science themselves and have limited knowledge of science and its processes.

The solution was a series of workshops for different audiences during which pre-K teachers, family day care home care providers, home visitors, and parents could see and experience hands-on science discoveries.

The expected outcomes were met during this practicum.

1. The teaching staff and workshop participants would develop a more positive attitude toward science, toward themselves as scientists and toward themselves as science teachers.

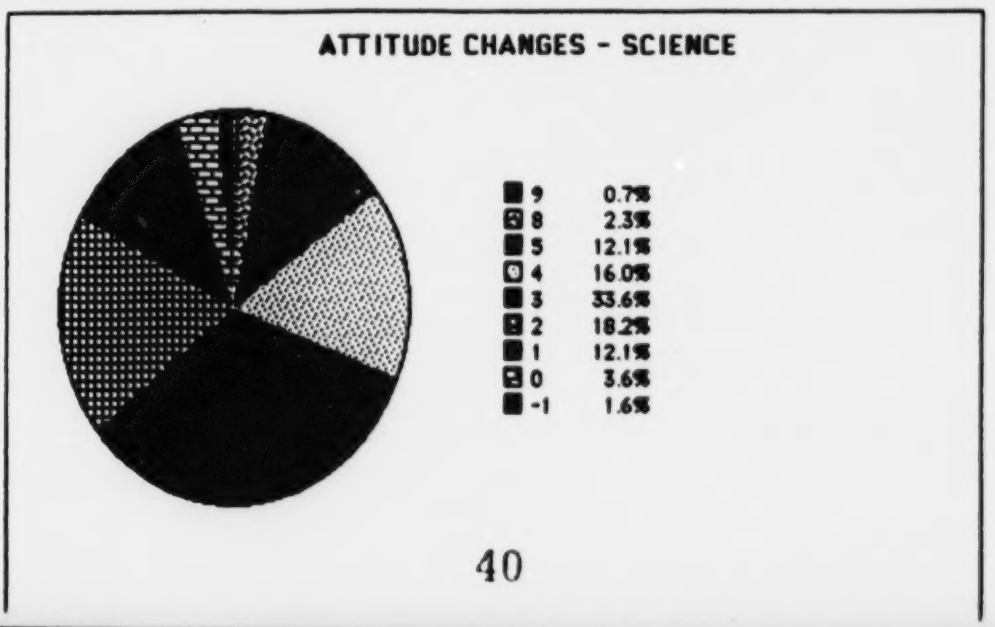
The informational survey showed that each group raised their positive scores in attitude toward science and toward themselves as science teachers. The idea that we are each scientists in our own life was not as universally accepted but because the original attitudes were very negative, there was improvement.

The following two matrices show the number of participants in each workshop

and the positive or negative change in positive words circled in the pre and post workshop attitude survey. For those who had a very low opinion of science and their own science teaching capabilities, the highest possible score was a positive 10 which would have reflected a change on each item on the scale. The pie charts show the percentages of each increment of change. The first four similar workshops are grouped together in the matrix with the symbol ●.

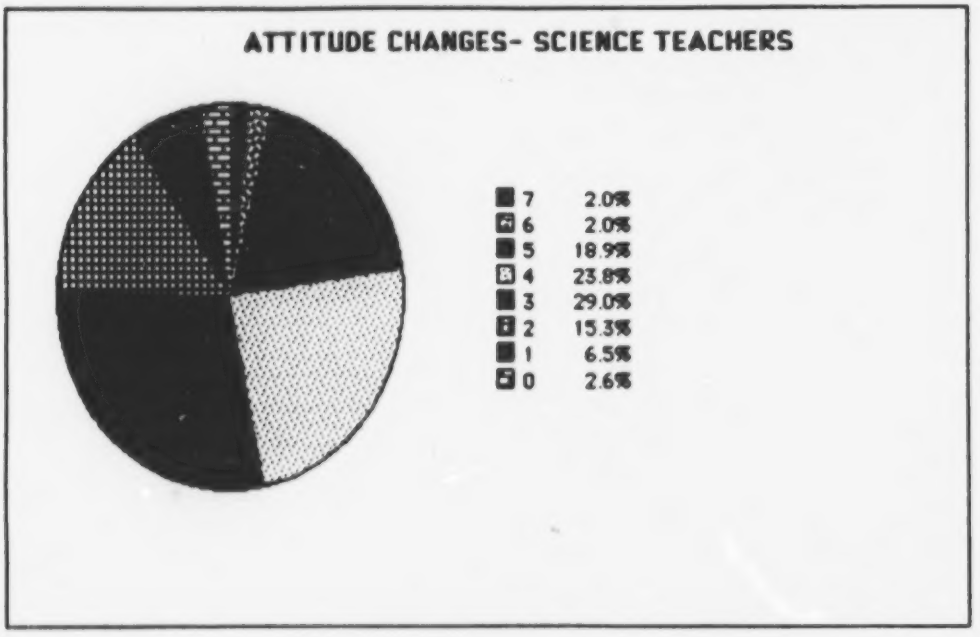
CHANGES IN ATTITUDE TOWARD SCIENCE

	WORKSHOPS					WORKSHOPS			
change	●	5	6	7	8	9	10	11	TOTALS
9	0	0	0	2	0	0	0	0	2
8	0	0	0	7	0	0	0	0	7
7	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
5	0	5	23	0	1	0	0	8	37
4	9	3	18	0	6	6	0	7	49
3	55	10	5	0	9	11	13	0	103
2	31	3	2	0	3	9	8	0	56
1	24	0	0	0	0	4	9	0	37
0	1	0	2	0	2	3	3	0	11
-1	1	0	0	0	0	0	4	0	5
-2	0	0	0	0	0	0	0	0	0
-3	0	0	0	0	0	0	0	0	0
TOTALS	121	21	50	9	21	33	37	15	307



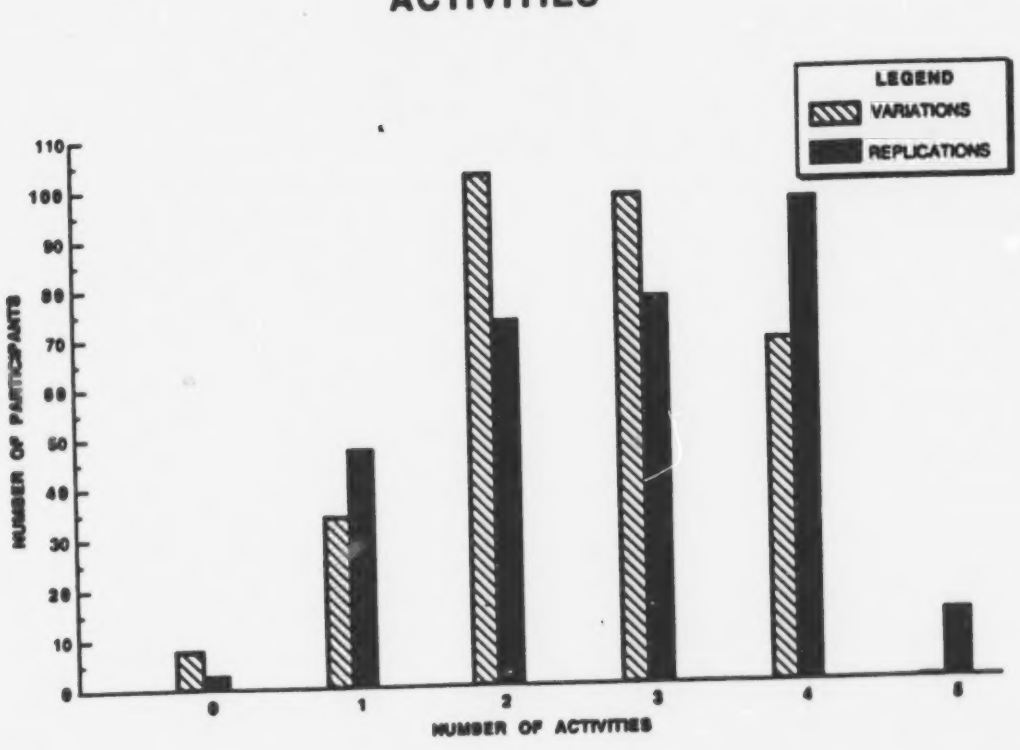
CHANGES IN ATTITUDE AS SCIENCE TEACHERS

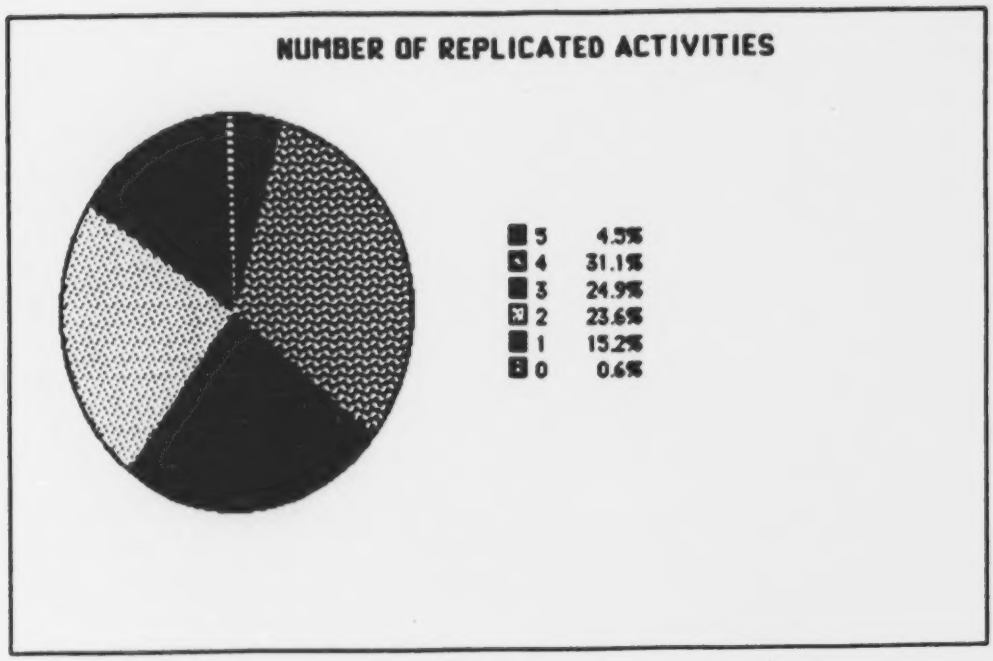
changes	WORKSHOPS 0	5	6	WORKSHOPS 7	8	WORKSHOPS 9	10	11	TOTALS
9	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
7	0	0	0	3	0	3	0	0	6
6	0	0	0	2	0	3	0	1	6
5	9	8	18	4	6	7	0	6	58
4	19	6	22	0	6	11	3	6	73
3	43	7	8	0	7	9	13	2	89
2	39	0	0	0	0	0	8	0	47
1	9	0	0	0	0	0	11	0	20
0	2	0	2	0	2	0	2	0	8
-1	0	0	0	0	0	0	0	0	0
-2	0	0	0	0	0	0	0	0	0
-3	0	0	0	0	0	0	0	0	0
TOTALS	121	21	50	9	21	33	37	15	307

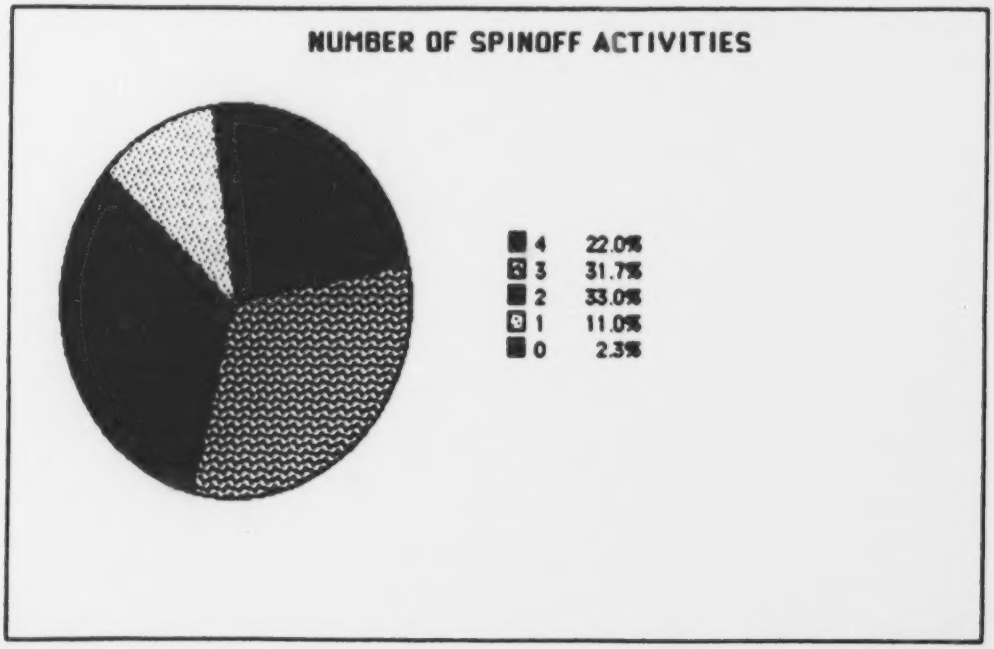


On the evaluation forms which were returned most of the participants had ideas of which of the hands-on activities they would replicate in their own classroom or home. Many had ideas of how they would change the activities to interest the individual children. Some had ideas of changing the developmental level of activities for individual children. Two administrators indicated that they no longer worked in classrooms, but they would look at classrooms and weekly activity plans to see how much (or little) science was going on.

The following bar graph shows the results of 299 evaluation forms which were turned in. The pie charts show the frequency of the number of responses by each participant.




NUMBER OF REPLICATED ACTIVITIES
5 4.5%
4 31.1%
3 24.9%
2 23.6%
1 15.2%
0 0.6%


NUMBER OF SPINOFF ACTIVITIES
4 22.0%
3 31.7%
2 33.0%
1 11.0%
0 2.3%

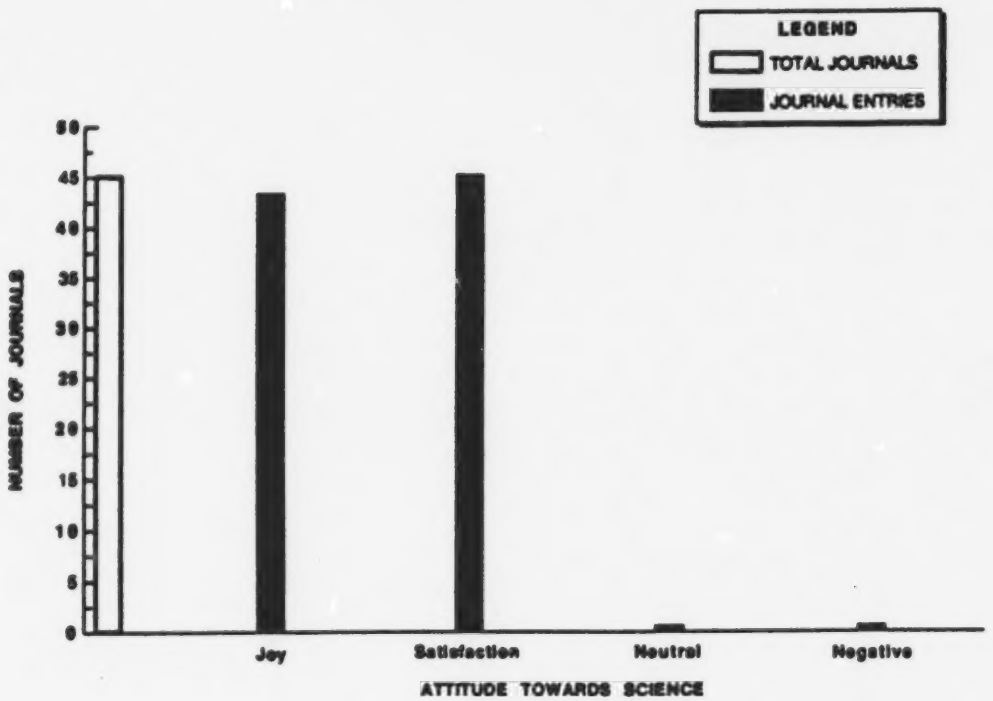
2. The teaching staff and parents/workshop participants will enjoy hands on discovery learning themselves.

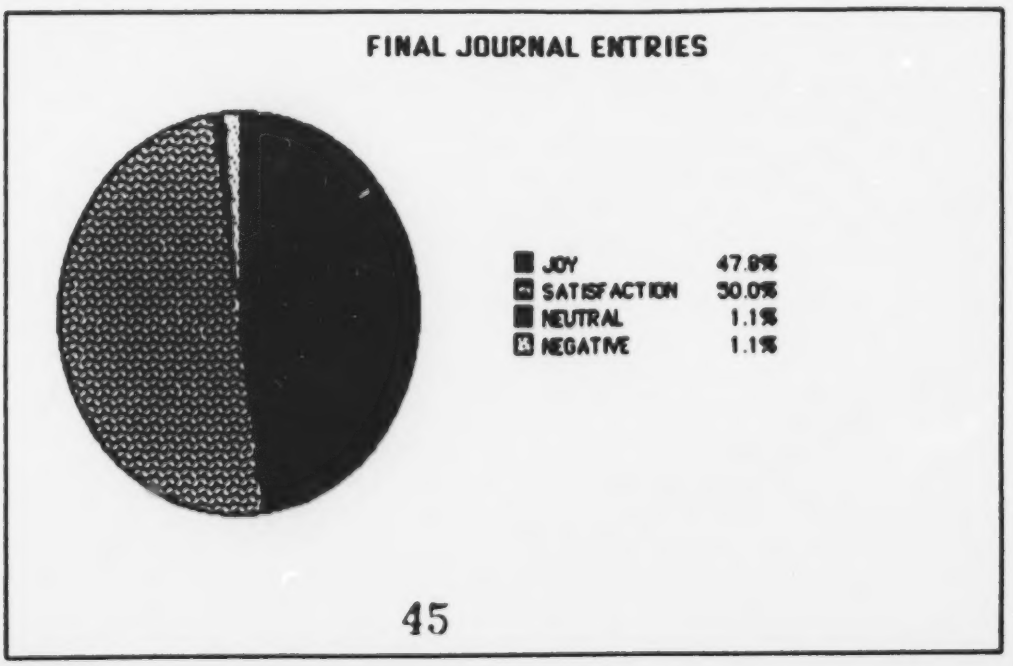
With the exception of three ladies who did not like to have the lady bugs touch them, all of the participants really enjoyed themselves. Every participant participated, 307 turned in the pre-post survey and 299 turned in the evaluation. Some who had forgotten or neglected to turn them in mailed them to me, because they knew I was very anxious to have a true understanding of the participants feeling. Another measure of their enthusiasm is the low number of participants who left early. Only 11 out of the total groups left early. The number that stayed for the full activity time was 298. Even after the end of the workshop, 76 stayed for the packing up and last chance to play by pouring out solutions and cleaning up. There were even a few (19) that kept talking about what they would do next week as the writer was trying to leave the parking area.

A surprising number of participants took the time to describe that activity which they enjoyed the most during the workshop. Words and phrases like "fun", "enjoy", "made me giggle", "reminded me of the fun of summer play", "like my brother messing around", "not since I was young, have I felt", " I did it myself!" " I made colors with water and sunshine." Another set of descriptors were, " I never before understood..". "Does water pressure always do that?" "It really worked." A written description of the activity that was the most fun was filled out by 274 out of 299 participants who returned the evaluation.

In the final journal entries the enthusiasm, joy, satisfaction, high level of confidence are clearly expressed. There is more than 100 % because some participants expressed feeling in more than one category on their final entry.

FINAL JOURNAL ENTRIES

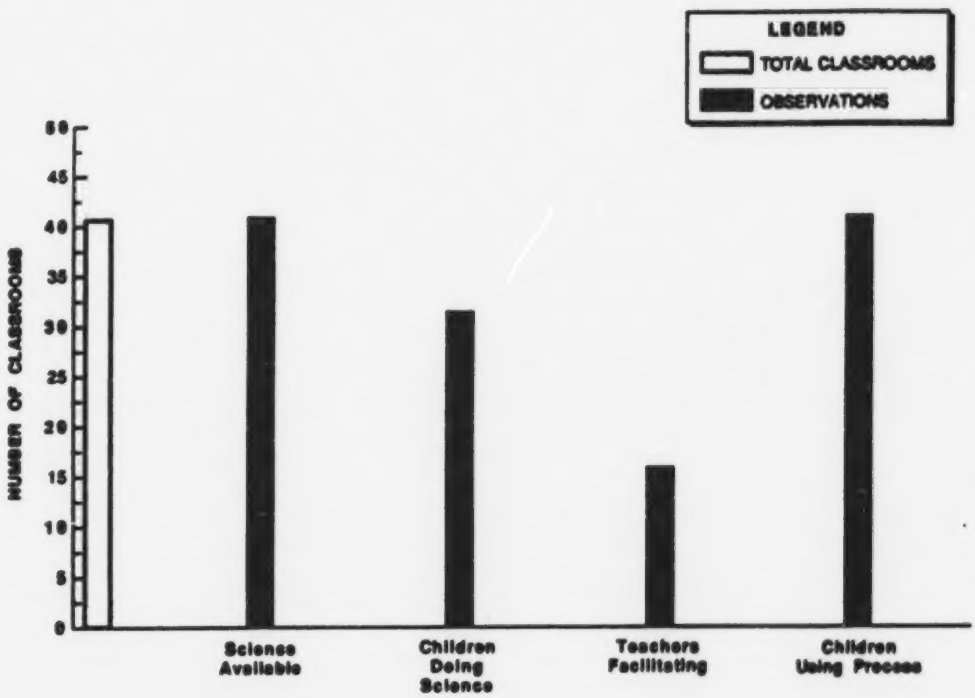




3. Hands on science activities would be available in the pre-K classroom four out of five days.

Classroom observation indicated science activities were available in all of the post-workshop classroom visits. The writer was able to personally observe 41 classrooms. The materials were available in every classroom and the teachers were consciously looking for opportunities to encourage the science processes of observing, communicating, comparing, ordering, and categorizing. Children in each classroom were using the science processes of observing, communicating, comparing, ordering, and categorizing.

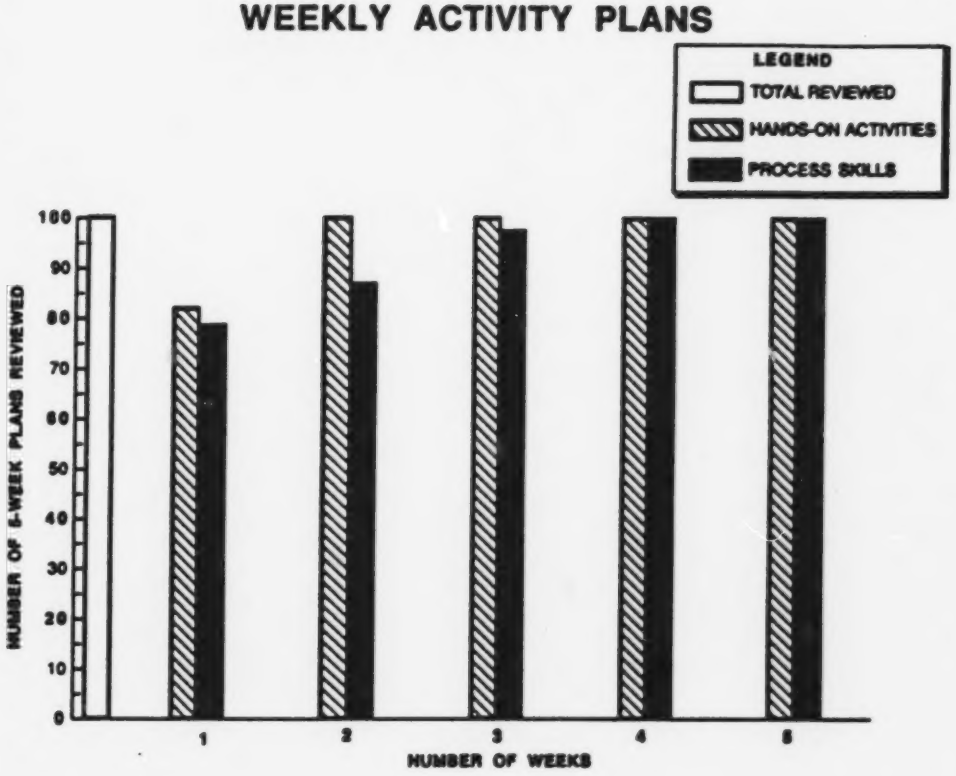
CLASSROOM OBSERVATIONS



4. Hands on science activities would be included in the weekly activity plan every week.

The review of the 100 five week activity plans or lesson plans showed developmentally appropriate science in every classroom which was reviewed.

Most of the classrooms were now having a science activity each week. This was an enormous change from the classrooms who had not participated in the workshops. Most of them are still reluctant and showing it in the plans only once or never in a five week span. Being conscious of the value of including the science processes in the plans appears to increase the frequency of doing it.



5. The workshop participants would model a science activity for the class.

During the final meeting of the five session class each of the nine participants demonstrated a hands on science activity which they had developed and for which they brought the materials and lesson plans for their classmates. The journal entries of the nine included descriptions of the difficulty some had in deciding what to bring. Perhaps this was the assignment which best prepared them to use what they had learned in class with their own pre-K children. For the scrounge workshops each participant of 121 demonstrated one of the activities which were provided by the writer/trainer as if they were a pre-K child. Different persons used the same materials in different ways as children of different developmental levels would. During the workshop for home visitors of infants and toddlers of 0-3-years-old some of the participants demonstrated activities with some of the available materials.

Recommendations

Using various audiences to deliver the concepts of hands on science and the processes of science taught the writer more about the learning styles and levels of science knowledge within each group. A deep bond of trust and friendship developed within each group of participants as they worked to better clarify concepts, enhancethe joy of doing, and support the growing confidence in themselves and in the learners with whom they work. Different metaphors and analogies were understood by different groups of adults working with pre-K children. However if one could work with the same group as an immediate supervisor or agency trainer one could track the adults' progress,and give some mentoring, coaching, observation and feedback which would enhance the adults' skills and insure the quality of the science presentations and activities in their classrooms.

Collaborative work groups within the workshop appeared to work most satisfactorily when they were mixed ability groupings. This is in line with the work on cooperative learning. The participants appeared to learn the most when the atmosphere was collegial, supportive, friendly, and the trainer appeared to be interested in each individual and the concerns they had about transferring actities and ideas to their work place.

This practicum was the writer's first experience with student/participant journals. Three college classes have now had journals as part of their regular weekly assignment. The students are becoming better writers and the instructor has a clearer sense of the learnings and feelings of all sixty students. It is a time-consuming process to read and respond to many journals, but the personal growth of the students is enhanced. Journals are an important addition and follow-up to any training session. The writer discovered that many students are at first uncomfortable with a journal assignment. For the second and third classes she provided clearer guidelines and optional formats.

Dissemination

The writer has been asked to provide two workshops in a month or two. One is for Head Start parents and directors of the region. The topic will be hands-on science activities with free and inexpensive materials in the home and in the classroom. The second is part of a National Science Foundation grant for a university. The topic is Safety in Science. The writer will be the only pre-K person in a group of K-12 educators. The activities and processes themselves and the manipulation of materials by collaborative learning groups will occur with explanations and handouts on the training process for trainers.

The resource library will continue to be available to the writer's adult students and teachers. The sharing that occurs around the resources is a valuable support for the teachers. The process of eliciting journal entries from the student/participants is being shared with colleagues in the community colleges. They are reporting that our mutual students are very excited about journal entries and instructor's response. The instructors and students report that they are very honored to have their ideas and feelings solicited in this way. I expect to use these concepts often as I move from a standard work week to a retired/consultant work week in two or three years.

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APPENDIX A

ATTITUDE SURVEY

NAME_____ DATE_____

ATTITUDE SURVEY

SHARE HOW YOU FEEL ABOUT SCIENCE AND ABOUT TEACHING SCIENCE BY ANSWERING THESE QUESTIONS.

PLEASE CIRCLE ALL THAT APPLY.

WHEN I STUDY SCIENCE OR THINK ABOUT LEARNING SCIENCE:

I FEEL CONFIDENT ADEQUATE SMART HAPPY

I FEEL COMFORTABLE UNCOMFORTABLE INTELLIGENT

I FEEL ADVENTUROUS UNFEMININE FRUSTRATED

I FEEL ASHAMED SCARED BORED STUPID

I THINK I'M GOING TO HAVE FUN.

I THINK ITS GOING TO BE BORING.

I THINK I WON'T UNDERSTAND IT.

I THINK I'M PRETENDING TO BE SOMEONE ELSE

I THINK I'M ABOUT TO HAVE AN ADVENTURE.

I THINK I'M GOING TO LEARN SOMETHING USEFUL.

I THINK I'M PLEASING MY PARENTS.

I EXPECT TO LEARN SOMETHING TO SHARE WITH MY CHILDREN.

I EXPECT TO LEARN SOMETHING TO USE IN MY CLASSROOM.

I EXPECT TO LEARN SOMETHING THAT WILL HELP ME WITH MY LIFE.

OTHER COMMENTS YOU WISH TO SHARE?

NAME_____ DATE_____

ATTITUDE SURVEY

SHARE HOW YOU FEEL ABOUT SCIENCE AND ABOUT TEACHING SCIENCE BY ANSWERING THESE QUESTIONS.

PLEASE CIRCLE ALL THAT APPLY.

WHEN I TEACH SCIENCE OR THINK ABOUT TEACHING SCIENCE:

I FEEL CONFIDENT ADEQUATE SMART HAPPY

I FEEL COMFORTABLE UNCOMFORTABLE INTELLIGENT

I FEEL ADVENTUROUS UNFEMININE FRUSTRATED

I FEEL ASHAMED SCARED BORED STUPID

I THINK I'M GOING TO HAVE FUN.

I THINK THE CHILDREN ARE GOING TO HAVE FUN

I THINK I WILL BE BORING.

I THINK THE CHILDREN WILL BE BORED3

I THINK THE CHILDREN WON'T UNDERSTAND IT.

I THINK WE ARE ABOUT TO HAVE AN ADVENTURE.

I THINK THE CHILDREN WILL LEARN SOMETHING USEFUL.

I THINK THE CHILDREN WILL SHARE WITH THEIR PARENTS.

I EXPECT TO LEARN SOMETHING TO SHARE WITH MY CHILDREN.

I EXPECT TO LEARN SOMETHING TO USE IN MY CLASSROOM.

I EXPECT TO LEARN SOMETHING THAT WILL HELP ME WITH MY LIFE.

OTHER COMMENTS YOU WISH TO SHARE?

APPENDIX B

WORKSHOP EVALUATION

EVALUATION OF THE HANDS ON SCIENCE WORKSHOP
FORM GROUPS OF TWO OR THREE AND SHARE YOUR EXPERIENCES IN THIS WORKSHOP.

WHAT ACTIVITY DID YOU ENJOY THE MOST?

NAME_____ DATE_____
WHAT ACTIVITIES FROM THIS WORKSHOP WILL YOU DO IN YOUR OWN CLASS?

WHAT CHANGES, ADAPTATIONS, AND INNOVATIONS MIGHT YOU MAKE?

CIRCLE THE MOST CORRECT DESCRIPTOR OR WRITE YOUR OWN DESCRIPTOR.

WAS THE WORKSHOP FUN? BORING? INFORMATIVE?

WAS THE PRESENTOR PREPARED? KNOWLEDGABLE?

WAS THE PRESENTOR ENTHUSIASTIC? HAVING FUN?

WOULD YOU ATTEND ANOTHER OF THESE WORKSHOPS? YES NO
ONLY IF.....

DID ANY PART OF THE WORKSHOP PROVIDE A COGNITIVE AHA! EXPERIENCE?

IF SO, WHAT?

DID ANY PART OF THE WORKSHOP PROVIDE AN EMOTIONAL AHA!EXPERIENCE?

IF SO, WHAT?

WHAT SUGGESTIONS DO YOU HAVE FOR NEXT TIME?

THANK YOU FOR YOUR PARTICIPATION

APPENDIX C

JOURNAL REVIEW CHECKLIST

WORKSHOP PARTICIPANT'S JOURNAL CHECK LIST

PARTICIPANT'S NAME_____

DATE

SCIENCE PROCESSES WHICH THEY USED IN THEIR CLASSROOM
How many?
more than previously same less than previously

different than previously same

SCIENCE CONCEPTS MENTIONED
How many?
more than previously same less than previously

different than previously same

EMOTIONAL TONE:
JOYFUL SATISFIED FRUSTRATED BORED APATHETIC TIRED

DATE

SCIENCE PROCESSES WHICH THEY USED IN THEIR CLASSROOM
How many?
more than previously same less than previously

different than previously same

SCIENCE CONCEPTS MENTIONED
How many?
more than previously same less than previously

different than previously same

EMOTIONAL TONE:
JOYFUL SATISFIED FRUSTRATED BORED APATHETIC TIRED

DATE

SCIENCE PROCESSES WHICH THEY USED IN THEIR CLASSROOM
How many?
more than previously same less than previously

different than previously same

SCIENCE CONCEPTS MENTIONED
How many?
more than previously same less than previously

different than previously same

EMOTIONAL TONE:
JOYFUL SATISFIED FRUSTRATED BORED APATHETIC TIRED

DATE

SCIENCE PROCESSES WHICH THEY USED IN THEIR CLASSROOM
How many?
more than previously same less than previously

different than previously same

SCIENCE CONCEPTS MENTIONED
How many?
more than previously same less than previously

different than previously same

EMOTIONAL TONE:
JOYFUL SATISFIED FRUSTRATED BORED APATHETIC TIRED

APPENDIX D

CLASSROOM OBSERVATION CHECKLIST

CLASSROOM OBSERVATION CHECK LIST

AGENCY_____SITE_____CLASS____

OBSERVER_____DATE_____TIME_____

SCIENCE ACTIVITIES VISIBLE

OBSERVATIONS OF CHILDREN "DOING SCIENCE" - using the science process.

OBSERVATIONS OF TEACHERS FACILITATING SCIENCE PROCESSES.

APPENDIX E

WEEKLY ACTIVITY PLAN REVIEW

WEEKLY ACTIVITY PLAN REVIEW

AGENCY_____SITE_____CLASS__

REVIEWER_____

WEEKLY ACTIVITY PLANS REVIEWED DATE_____

LIST OF DEVELOPMENTALLY APPROPRIATE SCIENCE ACTIVITIES OR LESSONS IN THE PLANS.

SCIENCE PROCESSES INCLUDED IN THE PLANS.

WEEKLY ACTIVITY PLANS REVIEWED DATE_____

LIST OF DEVELOPMENTALLY APPROPRIATE SCIENCE ACTIVITIES OR LESSONS IN THE PLANS.

SCIENCE PROCESSES INCLUDED IN THE PLANS.

WEEKLY ACTIVITY PLANS REVIEWED DATE_____

LIST OF DEVELOPMENTALLY APPROPRIATE SCIENCE ACTIVITIES OR LESSONS IN THE PLANS.

SCIENCE PROCESSES INCLUDED IN THE PLANS.

WEEKLY ACTIVITY PLANS REVIEWED DATE_____

LIST OF DEVELOPMENTALLY APPROPRIATE SCIENCE ACTIVITIES OR LESSONS IN THE PLANS.

SCIENCE PROCESSES INCLUDED IN THE PLANS.

WEEKLY ACTIVITY PLANS REVIEWED DATE_____

LIST OF DEVELOPMENTALLY APPROPRIATE SCIENCE ACTIVITIES OR LESSONS IN THE PLANS.

SCIENCE PROCESSES INCLUDED IN THE PLANS.

WEEKLY ACTIVITY PLANS REVIEWED DATE_____

LIST OF DEVELOPMENTALLY APPROPRIATE SCIENCE ACTIVITIES OR LESSONS IN THE PLANS.

SCIENCE PROCESSES INCLUDED IN THE PLANS.

WEEKLY ACTIVITY PLANS REVIEWED DATE_____

LIST OF DEVELOPMENTALLY APPROPRIATE SCIENCE ACTIVITIES OR LESSONS IN THE PLANS.

SCIENCE PROCESSES INCLUDED IN THE PLANS.

APPENDIX F

WORKSHOP TRAINING PLANS

TOPIC: SCIENCE WITH FREE AND INEXPENSIVE MATERIALS

OBJECTIVES:

1. Each participant will demonstrate during the work shop at least three activities which teach science concepts using the processes of observation description, communication and categorizing.

2, Each participant will make one piece of science equipment during the workshop, for instance the magnifying glass.

3. The participants will list six activities which they will try during the next two weeks.

CONTENT:

1. Participants will engage in ten hands-on activities.
2. Sources and displays of hands- on activities.
3. Demonstrations of how to make materials for the activities.

METHODS:

1. Active learning with hands-on materials.
2. Demonstrations and samples of materials.
3. Each participant will have their own materials for some activities and will rotate activities in order to try all of the activities.
4. Lecture on the principles of active learning and the processes of science.

SCHEDULE:

1. One workshop period of one and one half hour.

EVALUATION:

1. Comments of participants on evaluation form.

2. Observation of all participants actively engaged with the materials, taking notes and discussing possible adaptations with other participants.

3. Later comments from the co-workers and supervisors of participants about the change/nonchange in classroom.

TOPIC: SCIENCE FOR THE HOME

OBJECTIVES:

1. Each participant will participate in at least one science activity.
2. Each participant will experience active hands-on learning.
3. Each participant will make at least one piece of science equipment during the workshop, for instance the magnifying glass.

CONTENT:

1. Hands-on activities with household articles will be demonstrated.
2. Active learning will be demonstrated.

METHODS:

1. Active learning with hands-on activities.
2. Demonstrations and samples of materials.
3. Each participant will have their own materials for some activities and will rotate to other activities in order to experience as many activities as the participant wishes.
4. Group brainstorming of what science we know.
5. Lecture on the principles of active learning and the processes of science.
6. Translation into appropriate languages.

SCHEDULE:

1. One workshop of one to two hours depending on the available schedule

EVALUATION:

1. Comments on the evaluation form.

2. Observation of participants actively engaged with the materials.

3. Later comments by parent involvement coordinator or classroom teacher of later comments and suggestions during the days and weeks after the workshop.

TOPIC: SCIENCE FOR CHILDREN UNDER THREE

OBJECTIVES:

1. Each participant will demonstrate one activity for age 12 months.
2. Each participant will demonstrate one activity for a child of 18 months.
3. Each participant will demonstrate one activity for a child of 24 months.
4. Each participant will demonstrate one activity for a child of 30 months.
5. Participants will list the science processes.
6. Participants will be familiar with the developmental stages 0 - 3.
7. Participants will brainstorm a list of health and safety precautions.

CONTENT:

1. Participants will engage in ten hands-on science activities.
2. Sources and displays of other materials.
3. Demonstrations of how to use materials with children of various ages.

METHOD:

1. Each participant will have their own materials .
2. Video clips showing working with young children.
3. Hand-out of cognitive materials for babies.
4. Demonstrations and samples of materials.
5. Lecture on the principles of active learning, processes of science and developmental stages.

SCHEDULE:

1. One workshop period of one and one half hour.

EVALUATION:

1. Comments of participants on evaluation form.
2. Observation of participants working with the materials.

APPENDIX G

RESOURCE LIST

Resource List

Science as a subject, including teaching strategies and funding sources.

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